

EFFECT OF ALKALI TREATMENT CONDITIONS OPTIMIZATION ON
KENAF FIBER POLYESTER COMPOSITE CHARACTERIZATION

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For my beloved mother PATIMAH BINTI SAHDAN,
my father HASHIM BIN MARMAN, my dear wife SITI AISYAH BTE MISRAN,
my mother in law KHATIJAH BTE NORUDIN and my little hero
MUHAMMAD HARITH NAUFAL

“THANK YOU for your endless support”



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PERPUSTAKAAN TUNKU TUN AMINAH

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ABSTRACT

This study was conducted to evaluate the alkali treatment conditions optimization impact on kenaf fiber and its short random oriented kenaf fiber reinforced polyester matrix composite mechanical properties characterization. The selected treatment conditions are alkali solution concentration (2% w/v ~ 10% w/v), immersion duration (30 minute ~ 480 minute) and immersion temperature (room temperature ~ 100°C). Two types of experimental design approach were used in this work. It was three factors at three levels full factorial design for evaluating the kenaf fiber mechanical properties characterization and Response Surface Methodology (RSM) for determining the optimum alkali treatment conditions on kenaf polyester composite mechanical properties characterization. As the outcome of this study, the significant main-and-interaction effect of alkali treatment condition for kenaf fiber was determined. Furthermore, the correlation between optimum alkali treatment conditions with enhancement of kenaf fiber polyester matrix mechanical properties was suggested in the form of regression model. Based on the results, several regression models have been constructed according to Analysis of Variance and the regression model. Confirmation tests have been conducted towards selected predicted regression model. The confirmation test results shows good agreement with the proposed regression model. Finally, the outcome with a reliable database for optimum alkali treatment condition setting presented through this dissertation is expected to enhance insight regarding the knowledge of significant parameters in alkali treatment optimization that is extensively used in natural fiber surface treatment.

ABSTRAK

Kajian ini dilakukan untuk menilai kesan pengoptimuman parameter rawatan alkali ke atas ciri-ciri mekanikal gentian kenaf dan juga kompositnya yang diperbuat dari gentian kenaf pendek dan berterabur secara rawak yang dicampur poliester resin. Parameter untuk rawatan alkali adalah kepekatan larutan alkali (2% w/v ~ 10% w/v), tempoh rendaman (30 minit ~ 480 minit) dan suhu rendaman (suhu bilik ~ 100°C). Dua jenis kaedah rekabentuk eksperimen telah digunakan. Ia adalah kaedah rekabentuk faktorial penuh menggunakan tiga faktor di tiga tahap untuk menganalisa sifat mekanikal gentian kenaf dan kaedah Response Surface Methodology (RSM) untuk mengenalpasti sifat mekanikal komposit daripada kenaf dan poliester pada ketetapan rawatan alkali yang optimum. Melalui hasil kajian, faktor utama dan perkaitan diantara faktor semasa rawatan alkali untuk gentian kenaf telah dapat ditentukan. Selain itu, korelasi antara parameter rawatan alkali yang optimum dan mampu meningkatkan sifat mekanikal komposit berasaskan gentian kenaf dan poliester telah diterjemahkan dalam bentuk model regresi. Berdasarkan hasil kajian, beberapa model regresi telah dibina menggunakan analisa variasi dan model regresi. Ujian pengesahan turut dijalankan terhadap beberapa model regresi terpilih. Keputusan ujian pengesahan mempamerkan kualiti prestasi yang baik dengan model regresi yang dicadangkan. Kesimpulannya, maklumat data berkaitan rawatan alkali pada keadaan optimum yang disampaikan melalui disertasi ini dijangka mampu meningkatkan pemahaman dan memberi pengetahuan berkaitan parameter penting yang terlibat dalam mengoptimumkan proses rawatan alkali yang digunakan secara meluas untuk rawatan permukaan gentian asli.

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LIST OF SYMBOLS AND ABBREVIATIONS

\hat{y}_1	-	Predicted or estimates response
y	-	Measured responses variable
b_1, b_2, b_3	-	Regression coefficients
b_0	-	Intercept
ε	-	Experimental error
α	-	Alpha or Significance level of the test
ANOVA	-	Analysis of variance
ASTM	-	American Society for Testing and Materials
CCD	-	Central Composite Design
D	-	Desirability functions
d	-	Depth of specimen (mm)
d	-	Impactor diameter
DF	-	Degrees of freedom
DIN	-	German Institute for Standardisation
DMA	-	Dynamic Mechanical Analysis
DOE	-	Design of experiments
E_{max}	-	Impact energy (J)
EP	-	Epoxy
FCCCD	-	Face Centered Center Composite Design
GRP	-	Glass reinforced polymer
H_a	-	Alternate or experimental hypothesis
H_0	-	Null hypothesis

IFSS	-	Interfacial shear strength
ISO	-	International Organization for Standardization
KMnO ₄	-	Potassium Permanganate
L	-	Support span length (mm)
<i>L</i>	-	length of fiber
<i>L_o</i>	-	Length of elementary unit of the fiber
<i>m</i>	-	Number of responses
<i>m</i>	-	Weibull modulus
MAPP	-	Maleic Anhydride Polypropylene
MEKP	-	Methyl Ethyl Ketone Peroxide
MS	-	Mean squares
NaOH	-	Sodium hydroxide
NKTB	-	The National Kenaf and Tobacco Board
-OH	-	Hydroxyl groups
OVAT	-	One variable at a time
<i>p</i>	-	maximum probability
PE	-	Polyethylene
<i>P_f</i>	-	Probability index or estimators
<i>P_f(σ)</i>	-	Probability of failure
PLA	-	Poly- Lactic Acid
PP	-	Polypropylene
PP	-	Polypropylene
PS	-	Polystyrene
PUR	-	Polyurethanes
PVC	-	Polyvinyl chloride
R	-	Rate of crosshead motion (mm/min)
R ²	-	Coefficient of determination
RSM	-	Response surface methodology
RT	-	Room temperature
S	-	Standard error of a regression

SEM	-	Scanning electron microscope
SS	-	Sum of squares
σ	-	Stress
σ_o	-	Characteristic strength
σ_v	-	Lowest value of strength
σ_{impact}	-	Impact strength (kJ/m ²)
TAPPI	-	Technical Association of Pulp and Paper Industry
TGA	-	Thermo gravimetric analysis
UP	-	Unsaturated polyesters
UTS	-	Ultimate tensile stress
v	-	Volume fraction
V	-	Ratio of volume
V_f	-	Volume fraction
V_c	-	Composite volume
w	-	Weight fraction
W	-	Ratio of weight
W_f	-	Weight fraction
x_1	-	Alkali concentration (w/v%)
x_1x_2	-	Interaction
x_2	-	Immersion time (min)
x_3	-	Immersion temperature (°C)
Z	-	Rate of staining of the outer fiber (mm/mm/min)

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CHAPTER 1

INTRODUCTION

1.1 Introduction



"We do not *inherit* the earth from our ancestors, we borrow it from our children" is an ancient Indian proverb that could be a suitable phrase to emphasize the global challenges on environmental issues and energy crisis nowadays. As the world population increase rapidly, intense pressures are placed on earth resources to provide an adequate supply of food and other compulsory needs to support this incredible pace of change. According to the Concise Report on the World Population Situation in 2014, the world population was over 7 billion in late 2011 and expected to reach 9 billion people by 2050. In conjunction with increasing number of world population growth, it gives a significant impact on environmental and energy issues. The global crisis like climate change, oil peak, water resources, sanitary landfill, deforestation and many others challenge closely affected with the human activities either from its needs or from its wastes. The work presented in this thesis is not an attempt to solve the world problems but this is a small effort in contributing to the environmental sustainability aspiration. For that reason, this chapter discussed the overview of the study begins with research background section and followed by problem statement section. Research objectives, research contributions, research scopes, research methodology and research significance are presented in following section. Thesis organization was written at the end of this chapter.

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